Advanced Nuclear Fuels for More Capable and Sustainable Exploration

Completed Technology Project (2012 - 2016)

Project Introduction

Molten salt reactors are a subtype of reactor that uses nuclear fuel dissolved in a molten salt liquid medium (such as LiF-BeF2-UF4) as both fuel and coolant. The fuel is constantly circulating through the reactor core and other reactor systems. Molten salt reactors are an appealing technology for space because of their high temperature and low pressure operation, controllability, and high fuel burn up, among other features. The proposed research will investigate how molten salt reactor technology can be used to power sub-100 kWe reactors for science missions and for MWe class reactors for human exploration. Both of these applications are cited as relevant to current US goals in space in NASAs Draft 2010 Space Power and Energy Storage Roadmap, and will greatly assist in space exploration. Specifically, sub-100 kWe reactors are a potential solution to the Pu-238 shortage, and molten salt reactor technology can address the issue of controlling small reactors. MWe class reactors require large amounts of fuel and benefit greatly from operating at high temperatures. A MWe molten salt reactor is capable at operating at high temperatures and would require less fuel than its traditional solid fuel counterpart. Terrestrial MSRs have been recognized as a potential long term solution to Earths energy needs. Molten salt reactors have the ability to efficiently utilize thorium. Thorium is an alternative nuclear fuel that is roughly 4 times as abundant as uranium. In addition, the thorium fuel cycle produces comparatively little waste and has many proliferation resistant features compared to fuel cycles using uranium. Development of the MSR for space could result in spin-off technology to aid in the development of terrestrial MSRs. Specifically, the development of advanced multiphysics tools for MSRs, like those proposed here, will aid in the study, design, and licensing of future terrestrial MSRs. The research will use Monte Carlo nuclear simulation codes (MNCPX) and multiphysics simulations to explore to the role molten salt reactors can play in the exploration of the solar system. Design studies for various applications and organized trade studies for individual systems will be conducted. Key values such as specific mass, technology readiness levels, and possible development costs, will be produced. In addition, a number of specific technical questions, such as what power ranges in which EM pumps would be suitable for molten salt reactors, will be investigated.

Anticipated Benefits

Molten salt reactors are an appealing technology for space because of their high temperature and low pressure operation, controllability, and high fuel burn up, among other features. The research will investigate how molten salt reactor technology can be used to power sub-100 kWe reactors for science missions and for MWe class reactors for human exploration.

Project Image Space Molten Salt Reactors for More Capable and Sustainable Exploration

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Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Responsible Program:

Space Technology Research Grants

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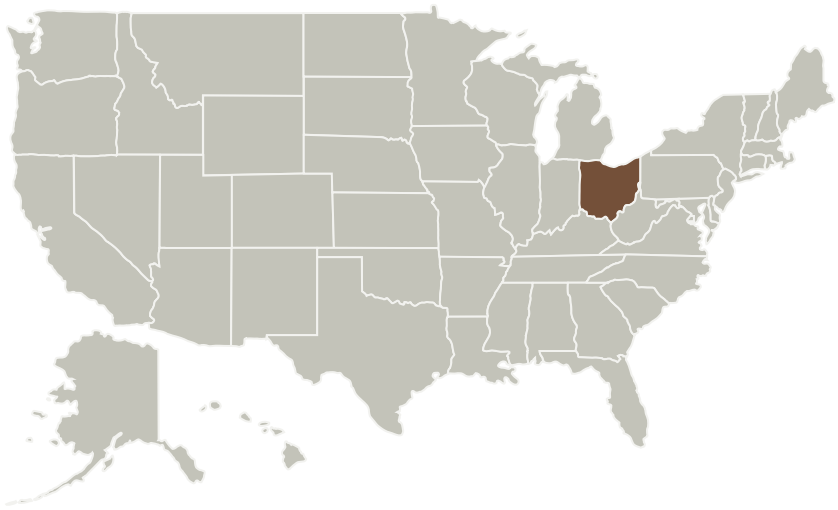
Primary U.S. Work Locations and Key Partners



Primary U.S. Work Locations
Ohio

Images

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Project Image Space Molten Salt Reactors for More Capable and Sustainable Exploration
(https://techport.nasa.gov/image/1826)

Project Management

Program Director:
Claudia M Meyer

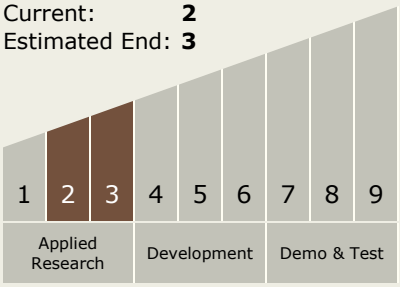
Program Manager:
Hung D Nguyen

Principal Investigator:
Thomas Blue

Co-Investigator:
Michael J Eades

Technology Maturity (TRL)

Start: **2**
Current: **2**
Estimated End: **3**



Technology Areas

Primary:

- TX03 Aerospace Power and Energy Storage
  - TX03.1 Power Generation and Energy Conversion
    - TX03.1.4 Dynamic Energy Conversion

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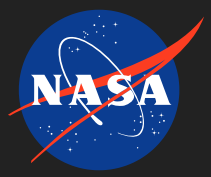

Project Website:

https://www.nasa.gov/directorates/spacetech/home/index.html